

## E12-09-011 Physics Analysis Possibilities

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We have an amazing amount of data from the KAON-LT experiment over a wide kinematic range. Below is my list of possible physics outputs from the acquired data, and my assessment of their potential physics impact and whether they should be short-term or long-term analysis goals.

Tentative names are placed next to many items. These, of course, are subject to change. Also, there is inevitable (and even desirable as cross-check) overlap between the work done by group members.

### 1. Physics from $K^+$ channels:

- (a)  $p(e, e'K^+)\Lambda/p(e, e'\pi^+)n$  ratios at low and high  $\epsilon$  (initial) and, later, investigation of separated ratios (e.g.  $\sigma_T(K^+\Lambda)/\sigma_T(\pi^+n)$  for various kinematics) and determination of  $g_{KN\Lambda}$ ,  $g_{NN\pi}$  coupling constant ratio versus  $t$ . These data could be vital in reducing the theoretical uncertainty in the  $g_{KN\Lambda}$  coupling constant.  
Tentative: Richard Trotta (cross sections), TBA (coupling const)
- (b)  $p(e, e'K^+)\Lambda$  beam helicity asymmetry (short term). Stephen Wood has already shown that the asymmetry is quite large, and hence interesting. There is a good chance the  $Q^2 > 2$  data could be the first publication from our experiment.  
Tentative: TBA
- (c)  $p(e, e'K^+)\Lambda$  L/T ratios versus  $-t$  (initial) and L/T/LT/TT separated cross sections (later) for  $Q^2 > 2 \text{ GeV}^2$ . Comparison to Regge and GPD models.  
Tentative: Richard Trotta
- (d)  $p(e, e'K^+)\Lambda$  L/T ratios versus  $-t$  (initial) and L/T/LT/TT separated cross sections (later) at  $Q^2 = 0.5 \text{ GeV}^2$ . If warranted by the data, extract the  $K^+$  electric form factor and compare to extrapolation of exact form factor values from CERN [Amen-dolia, et al, Physics Letters **B178** (1986) 435]. This is anticipated to be a high-impact Physical Review Letters publication.  
Tentative: Vijay Kumar
- (e)  $p(e, e'K^+)\Sigma/p(e, e'K^+)\Lambda$  ratios at low and high  $\epsilon$  (initial) and, later, investigation of separated ratios (e.g.  $\sigma_L(K^+\Sigma)/\sigma_L(K^+\Lambda)$  for various kinematics) and determination of  $g_{KN\Lambda}$ ,  $g_{KN\Sigma}$  coupling constant ratio versus  $t$ . This is listed as one of our  $K^+$  pole tests.  
Tentative: Richard Trotta (pole tests), TBA (coupling const)

- (f)  $p(e, e'K^+)\Lambda(1405)/p(e, e'K^+)\Lambda(1115)$ ,  $p(e, e'K^+)\Lambda(1520)/p(e, e'K^+)\Lambda(1115)$  ratios at high  $\epsilon$  for various kinematics (short term), and unseparated cross sections (later). Likely this will be possible only for the  $Q^2 > 2 \text{ GeV}^2$  data.  
Tentative: UofR BSc Honours project (initial studies), TBA (cross sect)
- (g)  $Q^{-n}$ -dependence of  $p(e, e'K^+)\Lambda$  L/T/LT/TT cross sections at  $x = 0.40$ , and comparison to QCD-scaling predictions. Longer term.  
Tentative: Vladimir Berdnikov (initial studies), TBA (final results)
- (h)  $K^+$  pole tests of separated  $p(e, e'K^+) d\sigma_L/dt$  for  $Q^2 > 2 \text{ GeV}^2$ , and, if warranted,  $K^+$  electric form factor versus  $Q^2$ . Flagship analysis, likely to be our highest cited work. Longer term goal.  
Tentative: Richard Trotta

## 2. Physics from $\pi^+$ channels:

Because of the substantial  $\pi^+$  leak-through into the  $K^+$  channel in certain kinematics, we have to look carefully at the  $\pi^+$  data before obtaining reliable  $K^+$  cross sections. In addition, we have several excellent opportunities for good physics publications from these data.

- (a)  $p(e, e'\pi^+)n$  L/T ratios versus  $-t$  (initial) and L/T/LT/TT separated cross sections (later) for  $Q^2 > 2 \text{ GeV}^2$ . Comparison to Regge and GPD models. In some kinematics, this will be limited by how well the high and low  $\epsilon$   $Q^2 - W$  diamonds overlap. See Monte Carlo studies done by Salina Ali.  
Tentative: Ali Usman
- (b)  $p(e, e'\pi^+)n$  beam helicity asymmetry, if it is sufficiently large to be interesting. Steve Wood has asked our intentions about these data.  
Tentative: TBA
- (c)  $p(e, e'\pi^+)n/p(e, e'\pi^+)\Delta^0$  ratios at low and high  $\epsilon$  (initial) and, later, investigation of separated ratios (e.g.  $\sigma_T(\pi^+\Delta^0)/\sigma_T(\pi^+n)$  for various kinematics). See GH's note at hlog 3640187 on the apparently very different L/T ratios of these two channels for  $Q^2 > 2 \text{ GeV}^2$ .  
Tentative: Ali Usman (initial studies), TBA (cross sections)
- (d)  $Q^{-n}$ -dependence of  $p(e, e'\pi^+)n$  L/T/LT/TT cross sections, and comparison to QCD-scaling predictions. With our new  $x = 0.40$  data, this has the potential to be a significant advance over our earlier study, "Scaling study of the pion electroproduction cross sections", Physical Review C **78** (2008) 058201. Longer term goal.  
Tentative: Vladimir Berdnikov (initial studies), TBA (final results)

- (e)  $\pi^+$  pole tests of separated  $p(e, e'\pi^+)n$   $d\sigma_L/dt$  and extraction of pion form factor for the  $Q^2 > 2$  GeV<sup>2</sup> settings at sufficiently low  $-t$ . Longer term goal.

Tentative: Ali Usman

- (f)  $p(e, e'\pi^+)n$  L/T ratios versus  $-t$  (initial) and L/T/LT/TT separated cross sections (later) at  $Q^2 = 0.5$  GeV<sup>2</sup>. If warranted by the data, extract the  $\pi^+$  electric form factor and compare to extrapolation of exact form factor values from CERN [Amendolia, et al, Physics Letters **B277** (1986) 168]. This would supplement the data taken at  $Q^2 = 0.4$  GeV<sup>2</sup> in the PION-LT experiment.

Tentative: Vijay Kumar

- (g)  $p(e, e'\pi^+)n$  L/T ratios versus  $-t$  (initial) and L/T/LT/TT separated cross sections (later) at  $Q^2 = 0.375, 0.425$  GeV<sup>2</sup> from PION-LT experiment. If warranted by the data, extract the  $\pi^+$  electric form factor and using also data from KAON-LT, compare to extrapolation of exact form factor values from CERN.

Tentative: Vijay Kumar

- (h)  $p(e, e'\pi^+)n$  beam helicity asymmetry from PION-LT experiment, if it is sufficiently large to be interesting.

Tentative: TBA

### 3. Physics from $p$ channels:

- (a) If the  $\rho$  missing mass peak can be reliably separated from the uncorrelated  $2\pi$  phase-space underneath,  $p(e, e'p)\rho/p(e, e'p)\omega$  ratios at low and high  $\epsilon$  (initial) and, later, investigation of separated ratios (e.g.  $\sigma_T(p\rho)/\sigma_T(p\omega)$  for various kinematics) and comparison to TDA and Regge model calculations at  $Q^2 > 2$  GeV<sup>2</sup>. This would be a nice initial study to have ready in time for the JLab  $u$ -channel workshop in May 2020.

Tentative: Stephen Kay (initial studies), TBA (final results)

- (b)  $p(e, e'p)\phi/p(e, e'p)\omega$  ratios at low and high  $\epsilon$  (initial) and, later, investigation of separated ratios (e.g.  $\sigma_T(p\phi)/\sigma_T(p\omega)$  for various kinematics) and comparison to TDA and Regge model calculations. This is of particular interest because  $u$ -channel  $\phi$  production is uniquely sensitive to the  $s\bar{s}$  component of the proton wave function.

Tentative: Stephen Kay (initial studies), TBA (final results)

- (c)  $p(e, e'p)\omega$  L/T ratios versus  $-u$  (initial) and L/T/LT/TT separated cross sections (later) for  $Q^2 > 2$  GeV<sup>2</sup>. Comparison to Regge and TDA models.

Tentative: Stephen Kay (initial studies), TBA (final results)

- (d)  $p(e, e'p)\omega$  beam helicity asymmetry and comparison to TDA calculations.

Tentative: TBA

- (e) If warranted by the data,  $p(e, e'p)\eta$  and  $p(e, e'p)\eta'$  cross sections at high and low  $\epsilon$ .  
See studies in Michael Hladun's B.Sc. Honours thesis.  
Tentative: UofR BSc Honours project (initial studies), TBA (cross sect)
- (f)  $Q^{-n}$ -dependence of  $p(e, e'p)\omega$  L/T/LT/TT cross sections at  $x = 0.40$ , and comparison to QCD-scaling predictions. Study also the  $W$ -dependence Longer term.  
Tentative: Stephen Kay (initial studies), TBA (final results)